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HABITAT SHIFT AND ROADSIDE MORTALITY OF SCARLET TANAGERS DURING A COLD WET NEW ENGLAND SPRING

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For insectivorous birds breeding at temperate or higher latitudes, the timing of arrival in spring is crucial. A primary hazard is to arrive too early when suitable food sources are lacking or when the birds would be subject to the effects of unsettled weather. Swifts, flycatchers, swallows, warblers, and tanagers appear to be especially vulnerable to extended periods of cold or rainy weather when they first arrive in the north (Forbush 1904, Bagg and Eliot 1937, Manville 1957). Scarlet Tanagers (*Piranga olivacea*), generally arboreal, have been recorded feeding on or near the ground during inclement weather (Hancock 1888, Eaton 1914, Bent 1958, Wetmore 1964, Bull 1974), often in habitats that differ from those typically occupied by the species (Nichols 1956, Manville 1957).

Such an event occurred in New England during a wet, cool period in late May 1974 when many insectivorous birds, but especially Scarlet Tanagers, shifted from their normal forest habitats to open areas where they engaged in extensive ground feeding. Some species, again primarily tanagers, suffered high mortality. This event has been described briefly by Kane and Buckley (1974), Kent (1974), and Finch (1975a). However, these authors presented little quantitative data on the magnitude of this phenomenon or its potential impact on breeding populations. In this paper, we describe the change in habitat and roadside mortality of Scarlet Tanagers and certain other insectivorous birds during spring 1974 in north-central New England, relate the phenomenon to decreased insect availability in forests caused by wet, cold weather, and consider its possible effect on tanager breeding populations.

METHODS

During spring 1974 we travelled frequently on the roads along the east-central border of Vermont and in west-central New Hampshire, mainly between the Hanover, N.H.-Norwich, Vt. area and the Hubbard Brook Experimental Forest, West Thornton, N.H. (Fig. 1).

From 26 May, when tanagers and other birds first began appearing along the roadsides, to 1 June, we made 41 surveys of the number of live and dead birds along segments of 2 Interstate and 8 secondary highways (Fig. 1). The surveys lasted from 5 to 40 min, each covering 4 to 27 km of roadway. Although some highway stretches were surveyed only once, other routes were travelled on several consecutive days. For each count, data were recorded on the times, distances, speed and direction of travel, on weather condi-

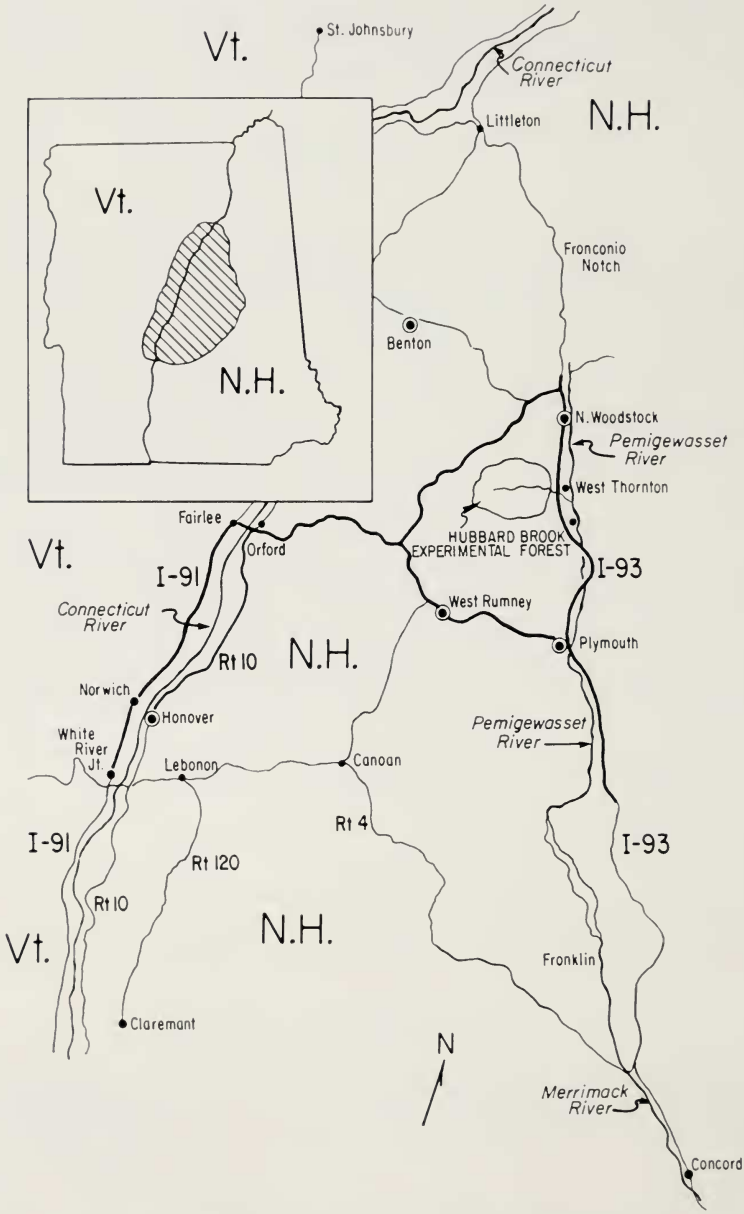

FIG. 1. Major area of occurrence (hatched in inset) of grounded tanagers and other birds along east border of central Vermont and in west central New Hampshire, 26 May–1 June 1974. Dark lines represent roadside survey routes. ◉ = locations where weather records were obtained. Scale: 10 cm = 52 km.

tions, and on the numbers of live and dead birds of each species encountered on the road or roadbed. Precipitation and temperature data were obtained from the climatological records of several local weather stations.

This roadside mortality count method has several limitations. Some dead birds undoubtedly are missed in such surveys because of (1) difficulties in observing birds on the road or roadside from a moving car, (2) injured birds dying some distance off the road, (3) corpses being thrown into dense vegetation along the roadside by the force of impact, and (4) corpses being removed by scavengers before being observed or becoming unrecognizable after a period of time on the road surface, especially in areas of heavy vehicular traffic. Because our study primarily involved a conspicuous species like the Scarlet Tanager, we feel that visibility was not a major problem; a few individuals of other less conspicuous species may have been missed. None of the highways received enough traffic for corpses to be obliterated, yet most carcasses disappeared by the morning after the individuals were killed, probably due to the activity of scavengers. This was considered a positive influence, since the "slate was wiped clean" each night, reducing the likelihood of double counting.

Information on breeding forest birds was obtained from studies in the Hubbard Brook Experimental Forest, West Thornton, N.H. (see Fig. 1 for location and Holmes and Sturges, 1975, for description of the study area and breeding census methods). Other observations were made throughout the region during the course of our travels and field work.

RESULTS

The phenomenon.—Scarlet Tanagers breed in deciduous and mixed forest throughout the northeastern United States and southeastern Canada. In central New Hampshire, they first arrive between 6 and 12 May, with the bulk of migrants usually appearing between 18 and 25 May (Holmes pers. observ.). In 1974, tanagers were first sighted in central New Hampshire on 9 May (Kent 1974) following the first small wave of migrant songbirds through eastern New England. The first significant migratory movement occurred on 14 May, followed by an extensive, unusually heavy migration between 16 and 18 May, and then a third substantial wave between 24 and 26 May. There was widespread agreement among observers in Rhode Island, Massachusetts, New Hampshire, and Maine that the spring songbird migration through these states was the heaviest in a decade or more (Finch 1975a). Many observers in Vermont and eastern New York reported that Scarlet Tanagers in particular appeared in greater numbers than usual (Kane and Buckley 1974).

On the morning of 26 May in parts of eastern Vermont and west-central New Hampshire tanagers and other birds left their normal forest and woodland habitats and began to appear on lawns, fields, and along roadsides in unprecedented numbers (see Table 1). Many were observed on or along highways on the gravel shoulders, the adjacent mowed grass, or on guardrails.

TABLE 1

OCCURRENCE AND MORTALITY OF BIRD SPECIES OBSERVED BETWEEN 26 MAY AND 1 JUNE 1974 ALONG INTERSTATE AND SECONDARY HIGHWAYS IN NORTH-CENTRAL NEW ENGLAND

Species	Number Observed on All Highways		
	Live	Dead	Total
Mourning Dove, *Zenaidura macroura*	3		3
Chimney Swift, *Chaetura pelagica*	1	2	3
Common Flicker, *Colaptes auratus*	1		1
Eastern Kingbird, *Tyrannus tyrannus*	26		26
Eastern Phoebe, *Sayornis phoebe*	2		2
Least Flycatcher, *Empidonax minimus*	4	1	5
Eastern Wood Pewee, *Contopus virens*		1	1
Unident. flycatcher, (Tyrannidae)	7	2	9
Olive-sided Flycatcher, *Nuttallornis borealis*	1		1
Barn Swallow, *Hirundo rustica*	2	2	4
Blue Jay, *Cyanocitta cristata*	2		2
Common Crow, *Corvus brachyrhynchos*	1		1
Gray Catbird, *Dumetella carolinensis*		1	1
American Robin, *Turdus migratorius*	48		48
Swainson's Thrush, *Catharus ustulata*	21	3	24
Unidentified thrush, *Catharus sp.*	7		7
Eastern Bluebird, *Sialia sialis*	1		1
Starling, *Sturnus vulgaris*	73		73
Red-Eyed Vireo, *Vireo olivaceus*		1	1
Cape May Warbler, *Dendroica tigrina*		1	1
Yellow-rumped Warbler, *Dendroica coronata*	1		1
Black-throated Green Warbler, *Dendroica virens*	1		1
Eastern Meadowlark, *Sturnella magna*	1		1
Red-winged Blackbird, *Agelaius phoeniceus*	13		13
Northern Oriole, *Icterus galbula*	5		5
Common Grackle, *Quiscalus quiscula*	11		11
Brown-headed Cowbird, *Molothrus ater*	21		21
Unidentified blackbird, (Icteridae)	1		1
Scarlet Tanager, *Piranga olivacea*	225	71	296
Dark-eyed Junco, *Junco hyemalis*	1		1
Chipping Sparrow, *Spizella passerina*	5		5
Total	485	85	570
% Scarlet Tanagers	46.4	83.5	51.9
Total birds/hour of travel	44.9	7.9	52.8
Total Tanagers/hour of travel	20.8	6.6	27.4

Tanagers in particular were extremely sluggish, permitting a close approach; many flew with difficulty even over short distances, preferring to hop slowly away.

During the next several days reports came in from Vermont and New Hampshire of flocks of tanagers on the ground and at feeders (Kent 1974, R. Chaffee pers. comm., Holmes pers. observ.), much to the amazement of the general public. Numerous dead tanagers were reported or delivered to the Dartmouth College Museum, the Dartmouth Biology Department, and the local newspapers. Kent (1974) cited cases of tanagers hawking insects over Stinson Lake, N.H., and falling into the water, too weak to return to shore; other tanagers landed on boats in the lake and some were even taken from holding tanks in a local fish hatchery. These birds avidly accepted food when it was offered to them. Other normally arboreal bird species were also displaced to these roadside or lawn habitats (Table 1). All individuals except the tanagers, however, appeared healthy and vigorous, and relatively few were found dead.

Geographical extent of grounded tanagers.—From our records and those of Kent (1974) and Finch (1975a), grounded tanagers occurred between 26 and 30 May from southern Maine to eastern Vermont, including most of the northern half of New Hampshire (Fig. 1). Tanagers were reported in greatest frequencies in the 2 major river valleys in the area, the Connecticut and the Pemigewasset-Merrimack.

Highway surveys.—Some species observed (Table 1) are typical of roadside habitats (e.g. starlings, cowbirds, robins), but others such as the warblers, vireos, Scarlet Tanagers, and some flycatchers occur normally in woodland habitats and feed primarily on foliage dwelling insects. More Scarlet Tanagers were observed (296) than all other species combined (274). Furthermore, the tanagers suffered the greatest mortality, accounting for 83.5% of the 85 birds found dead along the roadways.

About 4 times as many birds were observed per hour of travel along Interstates as on secondary highways, probably due to several factors. Birds are more conspicuous along Interstates because of the wide expanses of mowed shoulders, while on secondary roads, dead birds may be thrown into roadside vegetation and live birds can take refuge in the forest edge. Because Interstates have greater surface area of pavement, shoulder, and mowed lawn, they may provide more feeding habitat and thus may attract birds during periods of inclement weather. Finally, both Interstate highways surveyed were located in the major river valleys at elevations of approximately 250 m, while many of the secondary roads traversed higher ground (300–500 m). Our observations from Hubbard Brook Experimental Forest (500 m elev.) indicated that

TABLE 2

TEMPORAL VARIATION IN TANAGER OCCURRENCE AND MORTALITY ALONG VERMONT AND NEW HAMPSHIRE HIGHWAYS, 26 MAY TO 1 JUNE 1974

Date	Total Distance (Km) (Duration of Survey in Hours)	Number of Tanagers				Total Tanagers Per Hour of Travel
		live ♂	dead ♂	live ♀	dead ♀	
26 May	60 (0.8)	41	3	6	0	60.2
27 May	34 (0.8)	13	7	12	4	42.9
28 May	92 (2.0)	10	3	5	0	9.00
29 May	302 (5.8)	99	25	37	22	31.8
30 May	66 (1.0)	1	4	1	3	9.1
1 June	29 (0.4)	0	0	0	0	0.00
Totals	582 (10.8)	164	42	61	29	
Average						27.5

few if any tanagers remained in this forest after 26 May (see below), those tanagers that had arrived earlier having either died or moved away, perhaps to the lower valleys and thus to the Interstates.

No tanagers or other forest species were observed along roads between 23 and 25 May. The first and maximal number of tanagers occurred on 26 May when 60.2 tanagers were observed per hour of travel (Table 2). On subsequent days, the numbers generally declined through 1 June. The percentage of live tanagers decreased as the event progressed, due to increasing mortality of weak birds, to the return of the more healthy individuals to forest habitats, or both.

Fewer dead tanagers were found along roads in early mornings than in late afternoon (Table 3). This probably resulted from the accumulation of dead birds during the day, the movement of live birds away from the roads during the warmer parts of the day, and/or to the greater volume of traffic in late afternoon. Since the total number of tanagers observed was lowest in late afternoon (Table 3), it seems likely that the more vigorous birds had left the highways at that time probably to roost in nearby forests for the night.

Stomachs of 14 tanagers found dead along the roadsides contained primarily ants, beetles, and earthworms, all items that probably were obtained by ground feeding. In contrast, the usual spring and early summer diet of tanagers consists mostly of wasps, beetles, and lepidopteran larvae (Martin et al. 1951, Prescott 1965) obtained from forest canopies.

Tanager breeding survey.—Bird population densities have been followed continuously since 1969 in the Hubbard Brook Experimental Forest (Holmes and Sturges 1975), a locality near the center of this grounded-tanager phe-

TABLE 3

HIGHWAY MORTALITY OF SCARLET TANAGERS FROM 26 MAY–1 JUNE 1974 CATEGORIZED BY DIURNAL TIME PERIODS

Time	Total Distance (Km) (Duration of Surveys in hours)	Total Tanagers Per Hour of Travel	% Alive
05:00–10:30	117 (2.3)	31.9	93.2
10:30–15:30	179 (3.2)	45.6	80.6
15:30–21:00	286 (5.3)	14.7	51.3
Totals	582 (10.8)	27.5 (Average)	76.0

nomenon (Fig. 1). In 1974, the first Scarlet Tanagers to arrive at Hubbard Brook were recorded on 15 May. By 23 May, 3 to 4 males, the normal number occupying our main 10 ha census plot, were actively establishing territories and singing, and we frequently saw or heard tanagers in other areas of the forest. Only a few females had arrived by this time. When we next censused, during a break in the rain on 27 May, no tanagers were recorded on the census plot, nor anywhere in the forest. On that day, 2 dead males were found along a dirt road within the forest about 5 km from the Pemigewasset River Valley and Interstate 93. There was no evidence that they had been killed by cars; their stomachs were empty and we surmised that they had died of starvation or exposure. On 29 May, another dead male tanager was found on the forest litter in an undisturbed section of the forest, about 1 km from the end of a dirt road. Its stomach contained only 2 partly expanded but still rolled beech (*Fagus grandifolia*) leaf buds. There were no signs of bruises or physical damage on the tanager carcass. No other bird species seemed to have disappeared from the forest as completely as had the tanagers, although the numbers of all species on the census records during this time were low. No other species were found dead in the forest.

Between 2 and 6 June, several male and female tanagers reappeared on the census plot and in the forest in general, and nesting was underway shortly thereafter. The breeding density of tanagers that year was about ½ that of the previous 2 years and about ⅔ of the 1969–1973 average (Table 4). Tanager nesting success in 1974, although hard to assess accurately, appeared to be poor. Perhaps because of low breeding success and the high spring mortality of adults, the densities of breeding tanagers in the 2 subsequent seasons have been about ⅓ of the 1969–1973 average, the lowest in the 8 years of study at this locality (Table 4).

TABLE 4

BREEDING POPULATIONS OF SCARLET TANAGERS ON A 10 HA PLOT IN HUBBARD BROOK EXPERIMENTAL FOREST, WEST THORNTON, NEW HAMPSHIRE, FROM 1969 TO 1976

Year	Individuals Per 10 ha	Breeding Pairs Per 10 ha
1969	4.0	2.00
1970	6.0	3.00
1971	5.0	2.50
1972	8.0	4.00
1973	7.0	3.50
1974	4.0	2.00
1975	2.5	1.25
1976	1.5	0.75

DISCUSSION

Cause.—The habitat shift and occurrence of tanagers and certain other birds along roadsides in this late May period was correlated with, and lagged slightly behind, a period of cool rainy weather (Fig. 2). Persistent rainfall and/or low temperatures had a depressing effect on the activity of flying insects, as indicated by the numbers of insects captured in Malaise traps that were operating in the Hubbard Brook forest (Fig. 2). We feel that the reduced availability of aerial insects in the forests may have been a prime reason why the tanagers and possibly other species shifted their feeding into areas such as roadsides and lawns where they could obtain food more readily. This may have been particularly effective at this time in late May when these tanagers had just recently completed or were nearing completion of their northward migration.

Other observers have noted that birds often are attracted to the numerous insects that they find washed onto roads by heavy rains (e.g. Finnis 1960). In addition, earthworms and insects driven out of the ground by rain may be more visible to birds along roads and road shoulders (Kent 1974). The occurrence of more tanagers along the Interstates than along secondary highways, given the greater surface area of pavement, shoulder, and mowed lawn associated with Interstates, further supports this hypothesis.

One problem which the food (or any other) explanation for this phenomenon must address is that of the disproportionate effect on Scarlet Tanagers, relative to the other types of forest birds. It may be that this inclement weather occurred at the peak of the tanager migration which seems to be slightly later through this region than the peak migration periods of many other species (Holmes pers. observ.). As a result, tanagers may have been

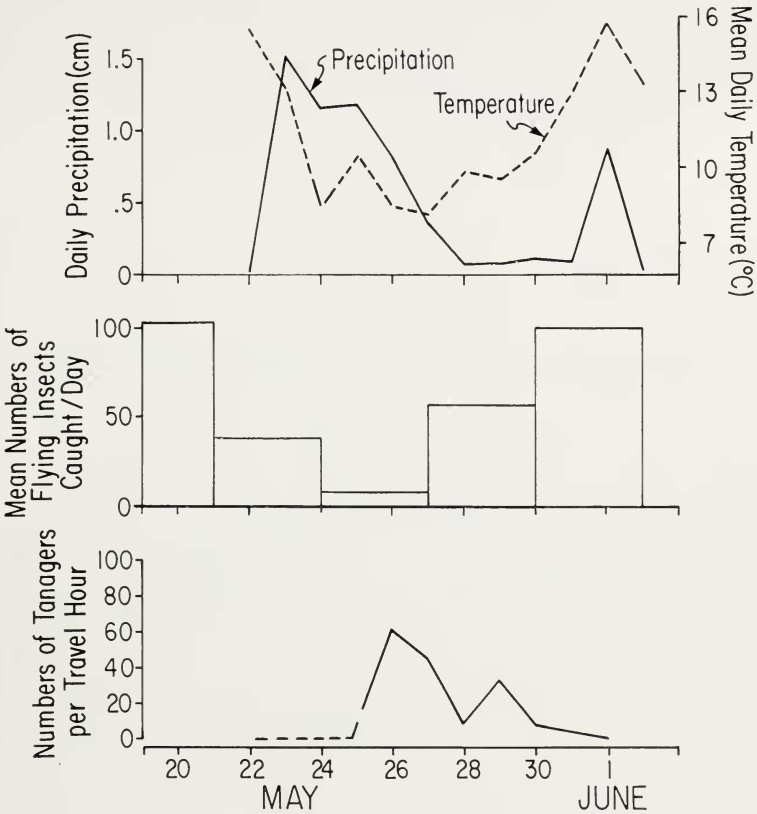

FIG. 2. Roadside occurrence of Scarlet Tanagers, relative abundance of insects, and mean daily precipitation and temperature in central New Hampshire, 20 May–2 June 1974. Insect data are from Malaise traps operating in undisturbed northern hardwoods, Hubbard Brook Experimental Forest, West Thornton, N.H. (500 m elevation).

less firmly attached to breeding sites and thus could shift more easily to better feeding areas on lawns and along roadsides. However, tanagers that had arrived previously and had been advertising territories in the forest for a week or more either died or left their territories in late May. Why didn't other species such as warblers and vireos also desert the forest in equally large numbers for better feeding areas?

We suggest that large insectivorous birds may be more severely affected than smaller ones under these circumstances, because of their greater dependence on relatively large-sized insect prey (cf Hespenheide 1975) which are normally relatively rare in the environment and which may be particu-

larly depressed in abundance during cool wet weather. This would also be related to the greater absolute metabolic needs of large birds, requiring a greater total intake of kcal per bird per day. Since the Scarlet Tanager is one of the larger insectivorous species in these forests feeding actively on flying adult insects (Prescott 1965; Holmes pers. observ.), it may be affected first or more severely than other species. This idea gains support from the fact that the Eastern Kingbird, another large flycatching species, was also strongly affected by this inclement weather. Although no habitat shift was involved, kingbirds were more abundant along the roadsides (see Table 1) and were seen feeding on the ground and road surfaces more often during, than either before or after, this period of inclement weather. Thus, we suggest that reduced availability of large prey items most suitable for large insectivorous birds, coupled with their greater absolute metabolic needs, might force the larger species to shift habitats sooner than the smaller ones. To evaluate these ideas further, more information is needed on the food selection processes of forest birds and on the responses of these species to changing food availabilities and climatic fluctuations.

Long term effects on Scarlet Tanager populations.—Finch (1975b) noted that the cold, wet weather of late May 1974 may have had a measureable effect on the nesting populations of certain species, notably Scarlet Tanagers and Swainson's Thrushes. Based on the results of the North American Breeding Bird Survey, Robbins and Erskine (1975) report that Scarlet Tanagers population declined 30% in New Hampshire and 50% in Maine in 1974 compared to those in the previous summer. In our 10 ha study area in the Hubbard Brook forest, we recorded fewer breeding pairs of tanagers during June and July 1974 as compared with the 5 previous summers (see Table 4) and nesting success was poor. In the summers of 1975 and 1976, even fewer tanagers were present. These findings suggest that the inclement weather of late May 1974 may have contributed to a significant several-year reduction in local Scarlet Tanager breeding populations at this locality.

SUMMARY

Roadside occurrence and mortality of Scarlet Tanagers and other insectivorous birds are described in relation to unseasonably cold wet weather in late May 1974 in New Hampshire and Vermont. More tanagers were observed in 41 roadside surveys than individuals of all other species combined, and 83.5% of the dead birds found were Scarlet Tanagers. Total numbers of tanagers observed per hour of travel were greater along Interstate than on secondary highways. The percentage of live tanagers on the roadsides decreased by mid-day.

Reduced availability of forest insects because of persistent rains and cool temperatures is considered to be the prime reason for tanagers shifting from forest habitats to roadsides and lawns, areas where they could obtain food such as ants and earthworms,

more readily. Tanagers may have been forced to desert their normal forest habitat sooner than other insectivorous species because of their relatively large body size, heavy reliance on large adult insects, and high absolute metabolic requirements. The local Scarlet Tanager breeding populations in the Hubbard Brook forest declined by 33% in 1974 over the previous year and by 67% in 1975 and 1976 over the 1969–1973 average, suggesting a possible long term effect of this period of heavy mortality.

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EDITORIAL: CHANGING OF THE GUARD

With this issue, my tenure as editor of The Wilson Bulletin is completed. I have enjoyed and learned much from having edited our journal and I hope that in some small way I have contributed to the success of the Society. Editing is a very time-consuming and often frustrating task, but it was made more enjoyable for me by the large measure of cooperation that I had from authors, referees, officers of the Wilson Society, editorial assistants, secretaries, and very importantly, Allen Press. During the past four years several hundred ornithologists contributed time and expertise to review manuscripts submitted to the Wilson Bulletin. Their efforts have made the Wilson Bulletin what it is today. I owe particular thanks to Lyda Eubank who, as one of our departmental secretaries, has handled much of the filing and correspondence associated with editing the Wilson Bulletin. Mississippi State University generously supported my editorial duties by providing office space and secretarial time for the Society. Ken Blair, our liaison at Allen Press, has contributed immeasurably over the years to the technical aspects of getting the journal out. I'm also aware of and grateful to the many "unknown" employees of Allen Press for a job well done.

To all who submitted manuscripts to the Wilson Bulletin—thanks for your perseverance and cooperation with the editorial process. To those whose manuscripts were rejected, I offer encouragement. Have faith in the peer review process. Make rejection a learning experience and do not let it dampen your enthusiasm in seeking new knowledge about birds. Perhaps a referee was wrong. I know I made mistakes—both in accepting and rejecting some manuscripts. While there are bound to be editorial errors made, I also feel that I've learned from my failures. We can all take some consolation in the strength of our profession and in the multitude of publication alternatives available to us. It has been particularly interesting to me to see which of the manuscripts rejected from the Wilson Bulletin eventually appeared in one of our sister journals and which rejected by one of them was eventually published in the Wilson Bulletin. To our new editor, Jon Barlow, I wish every success. He is full of enthusiasm and brings great expertise to the job. Support him.

JEROME A. JACKSON